

# CEMENT AND LIME MANUFACTURE

PUBLISHED 20TH OF EACH MONTH.

PRICE 1/- A COPY.

ANNUAL SUBSCRIPTION 12/- POST FREE

PUBLISHED BY  
CONCRETE PUBLICATIONS LIMITED  
14 DARTMOUTH STREET, LONDON S.W.1

TELEPHONE: WHITEHALL 4661.  
TELEGRAPHIC ADDRESS:  
CONCRETIUS PARL, LONDON

PUBLISHERS OF  
"CONCRETE & CONSTRUCTIONAL ENGINEERING"  
"CONCRETE BUILDING & CONCRETE PRODUCTS"  
"CEMENT & LIME MANUFACTURE"  
"THE CONCRETE YEAR BOOK"  
"CONCRETE SERIES" BOOKS, ETC.



VOLUME XIII. NUMBER 3

MARCH 1940

## Special Cements in Sweden and in Large American Dams.\*

By B. HELLSTRÖM, M.Inst.C.E.

CHAIRMAN OF THE INTERNATIONAL COMMITTEE ON SPECIAL CEMENTS FOR LARGE DAMS.

THE annual production of Portland cement in Sweden increased from 442,000 barrels in 1898 to 5,805,000 barrels in 1938; at the same time the compressive strength of cement mortar cubes has increased by nearly 50 per cent.

### Heat of Hydration and Crack Formation.

The improvement in strength has been obtained by various means, including improved methods of burning and finer grinding. Improvement in methods of mixing has rendered it possible to produce a specially homogeneous raw material of the most suitable chemical composition for obtaining high compressive strength. The improvement of the properties of cement, together with the more speedy rate of construction of recent years, have resulted in the evolution of heat in large masses of concrete, producing harmful changes in volume and large additional stresses in the concrete mass, often resulting in the development of cracks. Cracks are especially undesirable in hydraulic structures, in which they have a detrimental effect upon stability, watertightness and durability.

By means of thermometers embedded in the concrete its heat has been measured, and temperature rises of 60 deg. F. to 80 deg. F. are not unusual. Thus if the concrete is poured at an air temperature of 60 deg. F. a maximum temperature of 120 deg. F. to 140 deg. F. in the interior of the mass can be reached after one or two weeks. During low air temperatures at night the difference in temperature between the concrete in the interior of the mass and the concrete near the outer surfaces may be increased, causing tensile stresses in the outer layer

\* Translated from "Teknisk Tidskrift," Stockholm.

of the concrete and causing cracks. This development of cracks is facilitated by the low tensile strength of the concrete at this early stage of its setting.

In large concrete masses, where a great amount of heat has to be transferred to the air, the cooling takes a long time. For the difference in temperature between the air and the inside of the concrete mass to be reduced to one-fifth of the original difference, the following length of time is required:—

Thickness of concrete structure, in metres	Length of time for cooling
1	5 days
5	4 months
10	1 year and 4 months
20	5 years and 5 months

Several means of preventing the formation of cracks have been tried. By reducing the distance between the expansion joints, the size of the monoliths can be reduced. Some engineers consider that a block measuring 20 ft. long is the largest that can be poured without the danger of cracks being formed. It is often specified that the forms shall remain in place for weeks or even months with a view to preventing the temperature of the concrete surface from becoming too low before the temperature in the interior of the concrete mass has diminished in a sufficient degree. After the forms have been removed, the concrete surfaces are watered weekly to prevent dryness. Some engineers consider that the shuttering should be watered until it is removed. Formerly displacers were used in concrete, and they produced a heat compensation? Later, when it was found that the economy of the use of displacers was doubtful, the tendency was to increase the size of the broken stone beyond the usual 2 in. to 3 in., thereby obtaining a corresponding reduction of the proportion of cement in the concrete, so as to minimise the risk of cracking. In the United States broken stone of 6 in. to 9 in. has been used; in certain structures in Sweden stone up to 5 in. has been used. These precautions have not, however, been entirely satisfactory, and a cement having lower heat of hydration has been produced. In addition, in some large dams in the United States, the heat of hydration is now often dissipated by means of a system of pipes embedded in the concrete, through which cooling water is circulated.

#### Special Cement in the United States.

In the United States special cement for dams was produced on a large scale for the first time in 1932 and was then used in the 330 ft. high Morris dam in California. After some years of research work the U.S. Bureau of Reclamation considered that the problem of producing a good cement with a low heat of hydration was solved. In March, 1934, the Bureau published its first specification for such a cement, 75,000 tons of which were to be delivered for the Boulder dam, the highest dam in the world. In this connection it may be mentioned that an urgent demand for a suitable cement for dams was made by the International Commission on Large Dams at its meeting in Stockholm in 1933. This

led to the setting up in 1934 of an international sub-committee for the purpose of studying special cements for hydraulic structures and the methods of testing such cements.

At the congress of the International Commission on Large Dams held in Washington in 1936, Mr. J. L. Savage, of the Bureau of Reclamation, presented a report on the development of special cement in the United States. By a suitable composition of ordinary Portland cement (involving a reduction in the percentage of heat-developing substances such as tricalcium silicate and tricalcium aluminate and a corresponding increase in the dicalcium silicate and tetracalcium aluminoferrite contents) it was possible to reduce by 27 per cent. the heat of hydration during setting and hardening. Fine-grinding was also prescribed. This "low heat" Portland cement was used in the Morris and Boulder dams. In the



Fig. 1.—Boulder Dam.

latter the major portion of the heat of hydration was removed by cooling water. A view of the 740 ft. high Boulder dam is shown in *Fig. 1*.

The cement first used in the Boulder dam, however, had a rather low strength and hardened more slowly than ordinary Portland cement. This led to the production of "moderate-heat" or "modified" cement. This cement, too, was produced by a modification of the ingredients of ordinary Portland cement—the amount of tricalcium and dicalcium silicate was maintained and the amount of tricalcium aluminate decreased. It had approximately the same strength as ordinary Portland cement, but developed about 10 per cent. less heat of hydration. This cement was used in the Morris dam in Tennessee, in the Tygart dam in the Ohio Basin, and in the lower part of the Grand Coulee dam in the Columbia river.

Furthermore, the production of an entirely different type of cement having low heat of hydration was started. This so-called Portland pozzolanic cement was made by mixing and grinding together Portland cement clinker and pozzolana, and was used in the Bonneville dam in the Columbia river and for the concrete piers of the large Oakland and Golden Gate bridges in San Francisco. In the latter case it was of special value because the pozzolanic cement had a greater resistance to the action of sea-water than ordinary Portland cement.

In the last two or three years there has been in America a growing tendency to revert to the use of "low heat" cement, since it was found that considerable reduction in crack formation was obtained by the use of this type of cement. By the courtesy of Mr. Savage, the author is able to give brief descriptions of a



Fig. 2.—Parker Dam.

number of United States dams recently constructed, or in the process of construction, in which special cement has been used.

**PARKER DAM.**—This is an arch dam in the Colorado river, 124 miles downstream of the Boulder dam. *Fig. 2* shows the downstream face. The dam has a maximum height of 325 ft., of which 252 ft. is below the water level shown in the photograph. The arch is 100 ft. thick at the base and 50 ft. at the spillway sills. The dam was built in curved sections 50 ft. long; "low heat" cement was used for the concrete, which was cooled with circulating water. The quantity of concrete used was about 312,000 cu. yd.

**MARSHALL-FORD DAM.**—This is straight gravity structure situated in the Little Colorado river near the town of Austin, in Texas. Photographs of the upstream and downstream faces are given in *Figs. 3* and *4*. The greatest height of the dam in the first stage of construction will be 190 ft., and later it may be raised to

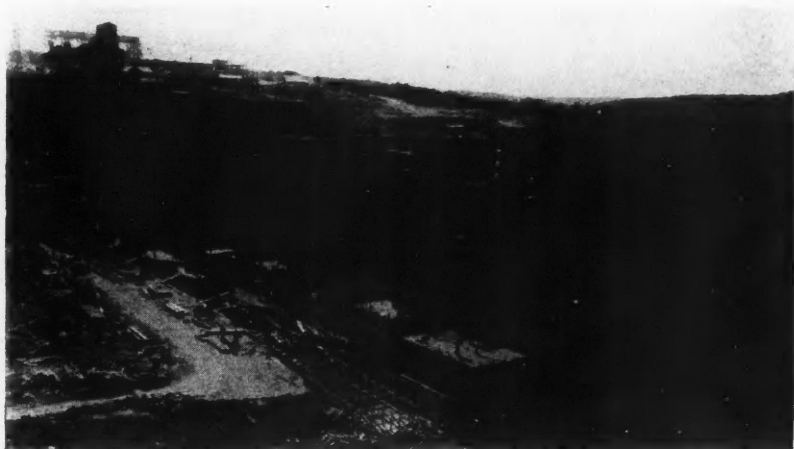


Fig. 3.—Marshall-Ford Dam (January, 1938).

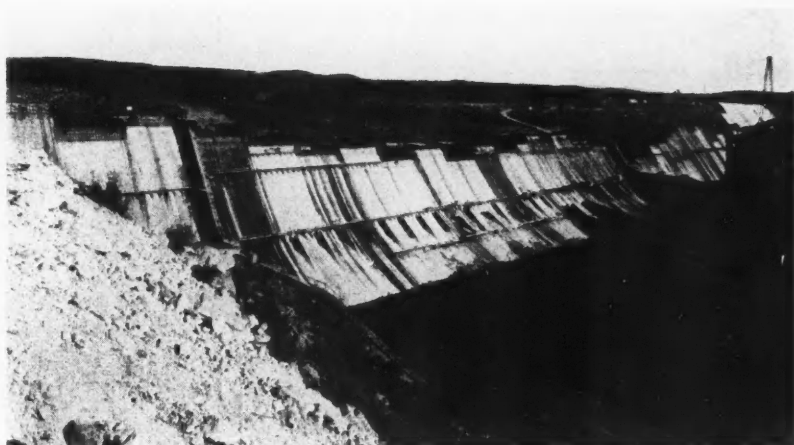


Fig. 4.—Marshall-Ford Dam (December, 1938).

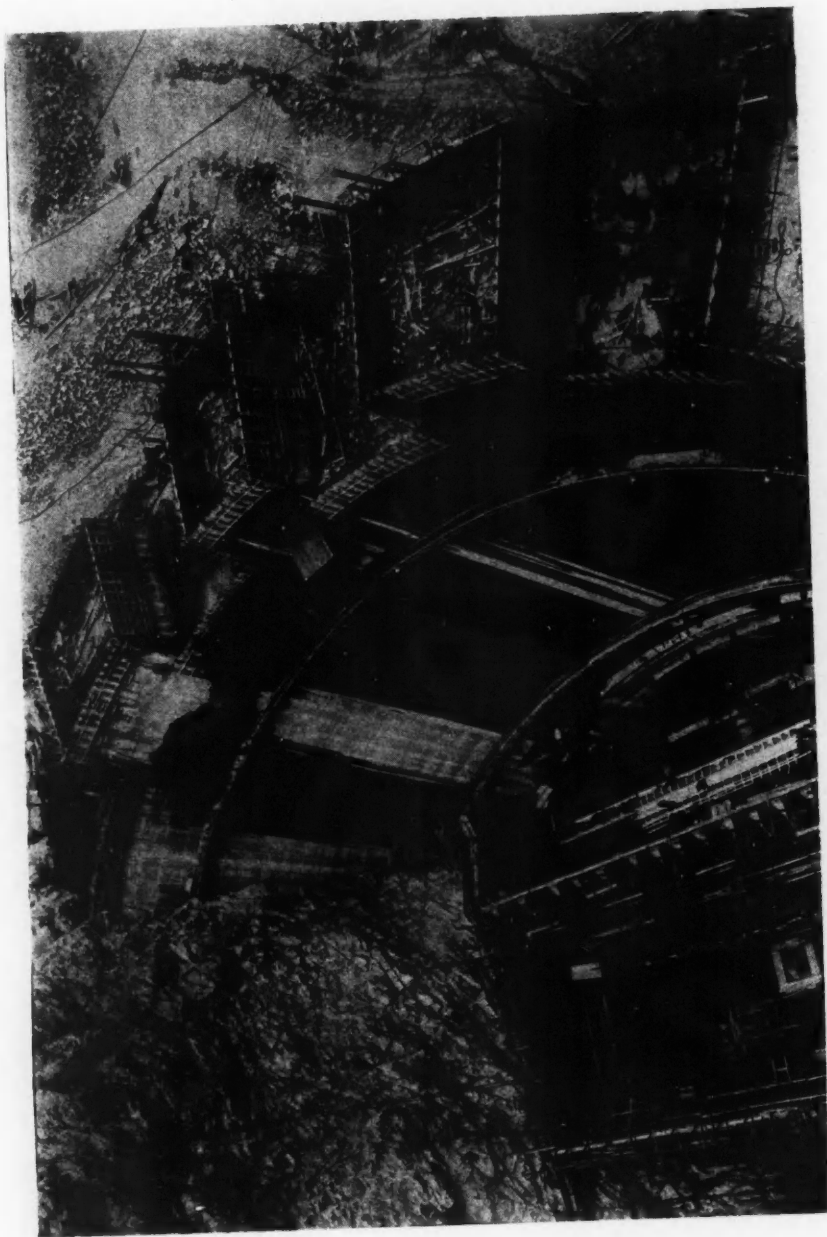


Fig. 5.—Seminole Dam.



265 ft.; from *Fig. 3* it can be seen that from the outset the foundation has been built for the final height. The upstream face is provided with horizontal recesses to facilitate future increase of the thickness of the wall. The distance between the expansion joints is 50 ft.; 910,000 cu. yd. of concrete made of "low heat" cement will be used in the first stage of construction. No cooling by circulating water has been resorted to at this stage.

**SEMINOE DAM, KENDRICK.**—This is a combination gravity and arch dam situated in the Platte river in Wyoming. A photograph of the downstream side appears in *Fig. 5*. The dam is 365 ft. high and the thickness is 90 ft. at the base and 15 ft. at the crest. Radial expansion joints are placed every 50 ft. or somewhat closer. The concrete, made of "low heat" cement, is cooled with circulating water as the pouring of the concrete advances. The portion of the work finished so far is remarkably free from cracks.

**BARTLETT DAM.**—This is in the Salt river, Arizona, and is a multiple arch dam of reinforced concrete. Its greatest height is 265 ft. The buttresses and arches



**Fig. 6.—Bartlett Dam : looking downstream.**

are 7 ft. thick at foundation level, and 2 ft. at the crest. The dam contains 162,000 cu. yd. of concrete made of "low heat" cement. The concrete was sprinkled with fine jets of water and, due to the high rate of evaporation in the dry desert air, its temperature was effectively lowered. No cooling system embedded in the concrete was applied. Upstream and downstream views are given in *Figs. 6* and *7*; in the latter is seen a "Saguaro Cactus," a striking indication of the desert character of the district.

**GRAND COULEE DAM.**—This is located in the Columbia river. Its content of concrete will be 9,750,000 cu. yd., and it will be the largest concrete dam in the world. It is a gravity dam, 565 ft. high and 4,350 ft. along the crest. Longitudinal and transverse expansion joints are placed at approximately every 50 ft. Heat removal is effected by means of a piping system through which water circulates. To a height of 285 ft. above the foundation "moderate heat" cement was

used, whereas "low heat" cement is used for the upper part. A noticeable reduction in crack formation is evident in that part of the structure in which "low heat" cement has been used in comparison with that made of "moderate heat" cement. *Fig. 8* shows the site in January, 1939.

**HIWASSEE DAM.**—This is being built by the Tennessee Valley Authority. The maximum height will be 300 ft. and the quantity of concrete about 780,000 cu. yd. "Low heat" cement is used.

**SHASTA DAM.**—The building of this dam in the Sacramento river is shortly to be started. "Low heat" cement is to be used. The height will be 565 ft. and the quantity of concrete about 5,200,000 cu. yd.

**FRIANT DAM.**—For this dam, which is to be built in the San Joaquin river, Portland pozzolanic cement will be used, composed of 80 per cent. of "low heat" cement and 20 per cent. of "Pumicite," a stone found in the district. The height of the dam will be 300 ft. and the quantity of concrete 1,800,000 cu. yd.

**Summary.**—It will be seen that "low heat" cement has to a great extent replaced ordinary Portland cement and "moderate heat" cement in the construction of dams in the United States. By the end of 1938 the Bureau of Reclamation had used more than five million barrels of "low heat" cement for its dams. It is now beyond doubt that the latter cement not only reduces crack formation but also meets all reasonable requirements in regard to workability and other properties. It is reported that it has not been possible altogether to exclude crack formation by using "low heat" cement (in some cases combined with water-cooling); it has been proved, however, that the cracks are smaller and considerably less numerous than when ordinary Portland cement has been used. The cost of the "low heat" cement used in the Boulder dam was about 4 per cent. higher than that of ordinary Portland cement. In the Morris dam this difference was 5.5 per cent. and the increase in the cost of the concrete was less than 1 per cent.

Little is known as yet about Portland pozzolanic cement, but it is now attracting great attention in the United States.

#### Special Cement in Sweden.

In 1931 the Royal Board of Waterfalls in Sweden took up the question of special cement for hydraulic structures in co-operation with "Cementa" (Swedish Cement Marketing Co.) and, due largely to Mr. Axel Ekwall (chief engineer of the Royal Board of Waterfalls) and to Professor Lennart Forsén, much progress has been made. In 1932 "Silicate" cement, a slow-hardening cement with a high proportion of silicate and a low proportion of lime, was put on the market. In 1934 the manufacture of "Pansar" cement, a Portland cement containing kaolin as the pozzolanic material, was started; two types were available: first, "Pansar A," a mixture of ordinary Portland cement clinker and 20 per cent. to 25 per cent. of Pansar pozzolana, and, secondly, "Pansar Silicate," containing 10 per cent. to 15 per cent. of Pansar pozzolana while the rest is "Silicate" cement clinker. A comparison between the strengths of the different types of cement is shown in Table I, in which the heat of hydration is also given.



TABLE I

Age of sample	Compressive strength, in kg. per sq. cm. (cubes cured in water)			
	Ordinary Portland cement (A-cement)	Special Cements		
		Silicate cement	Pansar Silicate cement	
28 days .. ..	515	472	507	
90 " .. ..	630	540	594	
1 year .. ..	582	586	625	
5 years .. ..	691	728	778	
Heat of hydration in calories per gram				
7 days .. ..	94	60	66	
28 " .. ..	104	86	72	



Fig. 7.—Bartlett Dam : looking upstream.

This comparison shows that for the shorter curing time the special cements have less strength than ordinary Portland cement, but the strength of the former increases more rapidly so that in a year their strengths are equal to or greater than that of Portland cement. The heat generated by the special cements is between 20 per cent. and 30 per cent. less than that generated by the ordinary Portland cement.

The Vargön power station is built with Silicate cement, which was also used at the Malfors power station. For the extension of the Trollhättan and the Stadsfors power stations Silicate cement was chiefly used. Pansar cement was used to a certain extent in the construction of the Krångede and the Dejefors power stations. On the other hand, ordinary Portland cement has been preferred in the construction of a number of new plants, e.g., the Långhag, the Skogsforsen, and the Kinna power plants. Sweden now has a wide experience, founded upon



Fig. 8.—Grand Coulee Dam under Construction.

actual practice, of all these cements with reference to workability, heat of hydration, etc. The results in regard to crack formation and resistance of concrete to the action of water, frost, ice and temperature variations can also be studied. An investigation of these questions has recently been made at the instance of the Swedish National Committee of the International Commission on Large Dams.

---

---

## Setting of Cement Under Gas Pressure.

In a recent number of "Industrial and Engineering Chemistry," Mr. J. Swearingen, of the University of Texas, states that several observations in high-pressure gas wells have indicated that the cement may not be setting when saturated with gas at extreme pressures. For instance, the mud blown from gas wells during the cleaning period often has the characteristic taste of cement; this may have been cement that was too diluted by the mud or water to set. In one case, where two strata separated by 4 ft. of hard formation were tested separately, there was an indication that the cement was not holding. In two wells used for injecting gas in re-pressuring operations, the casing head rose more than was expected. These findings prompted an investigation of the setting properties of cement under bottom-hole conditions and saturated at that pressure with wet natural gas.

Two comparative tests were made at a pressure of 3,100 lb. per square inch and 180 deg. F. on a slow-setting cement. The mould inside the bomb was 2 in. inside diameter and 6 in. long but was only two-thirds full of cement slurry. This allowed room for shaking and saturating the cement slurry with the gas while it was under pressure before it was left in an upright position to set. A similar test specimen from the same batch was allowed to set in the same thermostatic bath but at atmospheric pressure. The results are as follows:—

Setting time Hours	Water-cement ratio Gal. per sack	Compressive Breaking Strength Lb. per sq. in.	
		Gas-saturated Sample	Blank
48	5.5	4410	3973
96	5.5	4831	5140

The conclusion is that wet gas does not affect the setting of Portland cement, even at 3,100 lb. per square inch and 180 deg. F.

---

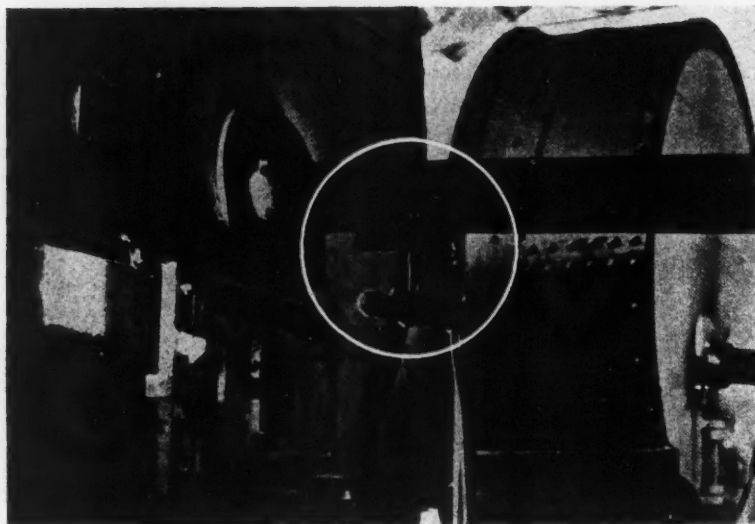
---

## Magnesia Bricks for Lining Cement Kilns

In the November, 1939, number of this journal, lines 14 and 15 of page 225 should read as follows: "Laying the bricks with steel flats is to be preferred to using cardboard spacers . . ."

## Automatic Kiln Control.

"ELECTRIC eyes," or phototube pyrometers, for controlling cement kilns are described in a recent number of *Rock Products*, where it is stated that ten kilns are being operated by the Lehigh Portland Cement Co. under vacuum-tube temperature control. The control equipment developed by the General Electric Co. makes use of phototube pyrometers which are instantly and constantly



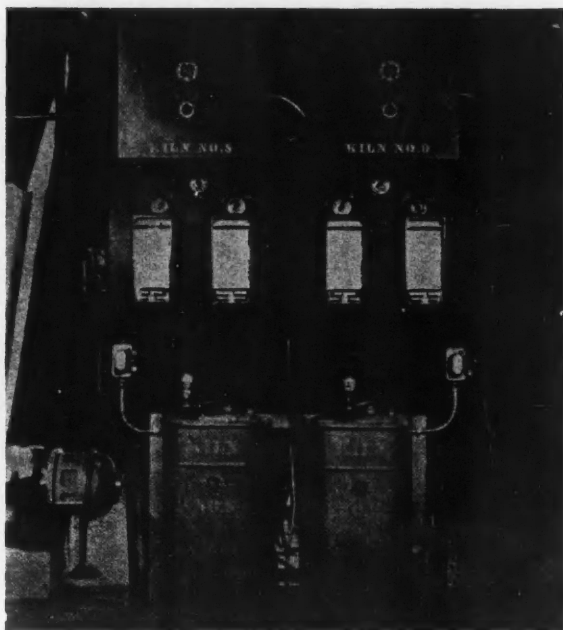
Phototube Pyrometer Installation on Kiln.

responsive to the energy radiated from the clinker to which they are exposed. By means of other tubes, contactors, and other devices, the temperature of the clinker and the speed of the kiln are indicated and recorded for each kiln, and the kiln speeds are controlled automatically to maintain the temperatures within the zone previously selected by the burner.

The motors driving the kiln are of the wound rotor (slip-ring) type, and hence speed control is by secondary resistance, speed adjustments being accomplished by contactors which short out in two steps about 20 per cent. of the total resistance used. Alternating current at 110 volts is supplied to the control equipment; this supply is subject to considerable voltage variation. A single tube with two anodes is used to rectify the alternating current to direct current. A voltage-regulating tube maintains constant voltage on the cathode circuit so that the electronic emission is constant. The direct current output of the

rectifier is controlled at 90 volts by another voltage-regulating tube that offsets any variation in the voltage impressed on the rectifier tube anodes. Hence the control is not affected by alternating current voltage variations. The direct current resulting is passed through a reactor or filter system to smooth out the ripples inherent in single-phase full-wave rectification.

The 90-volt direct current is impressed on a phototube which, when dark, passes no current, but when illuminated passes current proportional to the light impressed. In front of the tube a lens and aperture are provided, and the system

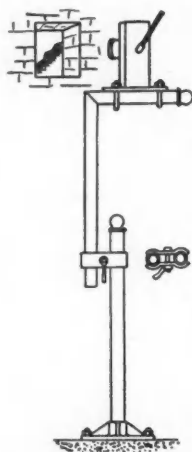


**Two Sets of Control Equipments, showing Automatic Control Panels at Top, Indicating and Recording Instruments in Centre, and Drum Switches for Starting and Manual Speed Adjustment.**

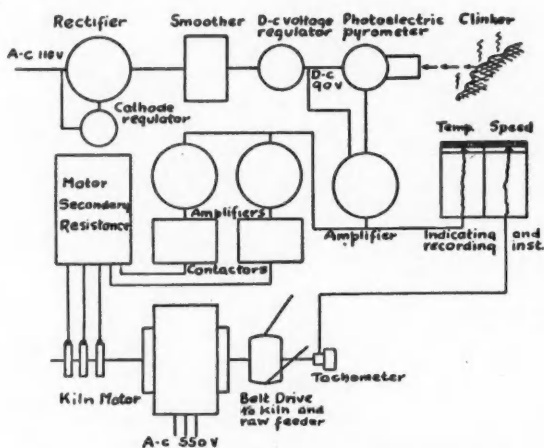
is focused on the brink of the clinker cascade as it emerges from contact with the flame. Any change in clinker temperature involves first a like change in radiant energy, and second, a like change in the current passed by the phototube. A resistance of many megohms is connected in series with the tube, and variation in current produces a like variation in the voltage drop across this resistance. Thus current variations are interpreted in voltage variations.

An amplifying tube is introduced across which the 90-volt direct current is impressed. A grid in this tube is connected to the phototube resistor and acts

as a damper or valve to control the thousand-times greater flow of current through the amplifying tube. This new output is sufficient first to indicate and record the temperature as "seen" by the phototube or "electric eye," and second, to act upon the grids of power tubes which pass sufficient current to operate contactors in the wound rotor secondary resistance circuits.



Phototube Pyrometer Support, providing Universal Adjustment.



Connections for Tubes and Auxiliaries for Temperature Control through Kiln Speed.

A small "tachometer" generator is sprocket-and-chain driven off the kiln drive, and its output actuates the speed indicator and recorder on which the voltage range is calibrated in revolutions per hour. Normal drum-switch control is used on the kiln motor for starting and zone-speed setting. Once brought up to speed, the automatic phototube control takes charge, and thence regulates the kiln speed to maintain the temperature within reasonable limits.

The dry screw feeder is driven by chain and sprocket from the kiln drive; hence it is synchronised, and any change in kiln speed is accompanied by a like change in feed. Fuel, air and draught are under independent manual control.



## Refractories for Cement Kilns.\*

By HENRY G. FISK, Ph.D.

### 1929.

(55) K. Endell. Thermal expansion and temperature sensibility of refractories in the cement industry. *Zement* 18, 1154-8 (1929). *C.A.* 24, 1484 (1930).—Data are given to show the properties of refractories of fireclay, sillimanite,  $\text{SiO}_2$ , and  $\text{MgO}$  during thermal change.

(56) Marc Elber. Refractories in rotary kilns. *Rev. mat. constr. trav. pub.*, pp. 361-64 (1929); *Refrac. Jour.* 5 (54), 236 (1930); *Cer. Abs.* 9, No. 6, 438-39 (1930); *C.A.* 24, No. 2, 479 (1930).—Factors influencing the deterioration of the refractory linings of rotary kilns are investigated, particularly those of the oxides of alumina and iron. The applications of silicon carbide are also discussed.

### 1930

(57) Shoichiro Nagai and Akitaro Mannami. Study of brick made of cement clinker. *J. Japan Cer. Assoc.* 38, 699-704 (1930). *C.A.* 26, (10), 2841 (1932).—Experiments were made on the effect of heating on the compressive strength and abrasion of clinker brick made of 1 part Portland cement, 0 to 3 parts Portland cement clinker ground to remain on a No. 20 sieve and 0 to 5 parts grog—70 per cent. of which passed a sieve of 225 meshes per sq. cm. after curing for 7 days in moist air.

(58) Alfred B. Searle. Refractory materials in cement works. *Refrac. Jour.*, 6 (62), 45-46 (1930). *Cer. Abs.* 10, (2), 122-3 (1931).—The refractory materials in cement works are (a) those used in boilers where the temperature is relatively low, and (b) those used in the hottest parts of a kiln in which a temperature of 1600 deg. C. may occasionally be attained. Ordinary close-textured fireclay bricks of accurate shape and laid with the thinnest possible joints are usually the best for lining the kilns, for they will withstand the high temperature, the corrosive action of free lime, the adhesion of the semi-molten clinker and the destructive effect of this material falling away, the hammering action of the cement-producing material as the kiln rotates, and the corrosive action of the flame and ash from the fuel. The most suitable brick or blocks for lining the hot zones are made of fireclay rich in alumina, notwithstanding the fact that Portland cement combines readily with fireclay to form a compound  $2.5\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 3\text{SiO}_2$ , which is the most fusible of this group of silicates. Most rotary kilns on the Continent are lined with bricks or blocks made of a mixture of fireclay and bauxite, the brick containing almost equal proportions of silica and alumina, i.e. in the same proportions as in the mineral mullite. If fireclay alone is used as much as possible of it should be calcined at the highest available temperature and so converted into grog. When the diameter of the kiln will permit, a ring of insulating bricks made of kieselguhr or other diatomaceous earth should be inserted between the lining and the shell. Bricks required for lining shaft kilns need not be of so high a quality as for rotary kilns. Resistance to corrosion and abrasion are the most important characteristics,

\*Continued from December, 1939, and January, 1940.

while refractoriness is essential. Fireclay bricks, fairly rich in alumina and grog, are the most suitable, and for the hottest zone, which is somewhat below the middle of the kiln, the more aluminous the bricks the more durable they are likely to be. A close compact texture is desirable. Plastic materials known as cements are sometimes used for repairing cement kilns. They are good for patching but not suitable for permanent work, as they have a different co-efficient of expansion and do not adhere well to the brickwork.

(59) O. Frey. Clinker concrete as lining for the rotary and shaft kiln. *Zement* 19, (11), 239 (1930).—A refractory grade of clinker with a high lime content must be used. Blocks must be cured for three or four weeks before use. Clinker blocks have the following advantages: (1) They are an ordinary commercial product. (2) The used clinker lining can be ground up for cement. (3) Low cost of installation. (4) Chemical stability between lining and charge. (5) Production requires no special equipment.

(60) O. Frey. Choosing linings for rotary cement kilns. *Rev. mat. constr. trav. pub.*, No. 252, pp. 349-50 (1930); *Zement* 19, 492-3 (1930); *Cer. Abs.* 10, No. 2, 123 (1931).

(61) J. Schaefer. Testing refractories for cement kilns. *Zement* 19, 1112-3 (1930). *C.A.* 25, No. 11, 2829 (1931).—It is pointed out that the chemical composition of the raw feed has an influence on the lining; also the fusing temperature of the clinker as well as that of the refractory. Methods previously used to test cement kiln refractories include: (1) Mixing powdered clinker and refractory material and making cones and determining the softening temperature of the cones; this method is not reliable. (2) Placing the raw mix or clinker in a depression in the refractory material and firing. This method is superior to (1) but does not show whether the refractory will take a coating; also it fails to simulate service conditions since the clinker moves in a kiln and in this test the abrasive or mechanical wear is not introduced. In order to overcome these objections a test was devised in the laboratory of the Dynamidon works. The test is made by blasting raw mix or powdered clinker introduced into a gas flame on the face of a brick. By this means mechanical as well as chemical attack is introduced. The brick is heated to 1500 deg. F. to 1600 deg. F. in about one hour. Then a stream of cement is allowed to flow by gravity into the flame at the rate of 500 g. in 40 minutes. The small particles fuse and react chemically with the brick, while the large particles attack the brick mechanically. At the conclusion of the test the brick can immediately be removed and tested for spalling resistance, which is greatly influenced by the adhering or penetrating clinker. A diagram of the furnace and photographs of the test results are given. A patent on the furnace and method of testing is being sought.

#### 1931

(62) Anon. Choosing refractory linings for rotary kilns of cement plants. *Rev. mat. constr. trav. pub.*, No. 262, pp. 127-28B (1931). *Cer. Abs.* 10, No. 12, 845 (1931).—Materials should be studied in regard to (1) vitrification of the fired material, (2) fusion, (3) silica ratio, and (4) analysis. Points (1) and (2) are explained in detail.

(63) H. Kühl, J. Lorenz, and F. Thilo. Observations on rotary kiln linings. *Zement*, 20, Nos. 39, 40 (1931). *Rock Prod.* 35, No. 14, 36 (1932).—The authors present results of study of a kiln lining after a shut-down. They conclude that in the wear on the lining there are reactions between the lining, the cement, and the fuel ash, and an important role is played by the gas phase and with distillation and condensation processes.

(64) O. Frey. Coating of cement clinker in shaft and rotary kilns. *Tonind. Ztg.* 55, 642-44 (1931).—The author compares the action of various factors affecting the formation of coatings on the refractory lining of shaft and rotary kilns.

(65) Hachiro Saito. Lining bricks for rotary cement kilns. U.S. pat. 1,817,421, Aug. 4, 1931. *Cer. Abs.* 10, No. 10, 709 (1931).—A lining brick for kilns comprises a brick composed of a super-refractory material, the brick being provided with a plurality of recesses and a plurality of clay bricks in the recesses, the surfaces of the refractory bricks and clay bricks being in alternate positions on the face of the lining brick.

(66) A. E. Fitzgerald. New developments in unfired magnesite brick for the metallurgical industry. *Mining and Met.*, 12 (300), 527-32 (1931).—*Cer. Abs.* 11, No. 4, 248 (1932).—Magnesite brick production requires special methods which ordinarily include two firings. Early unfired magnesite bricks showed two defects: (1) the brick shrank, and (2) sintering did not extend to brickwork which attained only intermediate temperatures. To overcome this shrinkage the moulding pressure was increased from 1,000 to 10,000 lb. per square inch, interfitting of the grains was developed to a maximum by gradation of particle sizes, and a colloidal coating was used as a lubricant between the particles. The unfired bricks showed greater cold-crushing strength, lower abrasion loss, lower shrinkage at 2700 deg. F., and superiority in load tests. The unfired bricks had a marked resistance to spalling, no loss being suffered in 20 cycles at 1000 deg. C. The unfired bricks also had less permeability to gases under pressure. Some industrial applications of these bricks are discussed in detail. Illustrated.

(67) Anon. Bricks for lining cement kilns. *Brit. Clayworker*, 40 (476), 323 (1931). *Rev. mat. constr. trav. pub.*, No. 271, 150-151 (1932). *Cer. Abs.*, 11, No. 5, 310 (1932).—Manufacturers of Portland cement require bricks having several conflicting properties for lining kilns in which cement is clinkered. The refractoriness of the lining should at least be equal to cone 34 (1750 deg. C.) because the temperature of the clinker reaches 1500 deg. to 1550 deg. C. and that of the flame in contact with the lining is still higher. Highly siliceous bricks are useless because the clinker attacks them violently and corrodes them rapidly. Basic bricks appear impracticable at present and the best material available is a highly-aluminous one. A dense structure is desired, i.e. having a volume weight of not less than 2.4. The bricks must have low shrinkage in use to enable them to retain their position in the kiln, and not allow undue penetration of clinker between them. High resistance to abrasion is required because the clinker travelling through the kiln has an abrading and a plucking action. A good lining should last 10 to 12 months in the hottest parts of the kiln.

(68) K. A. Goslich. Magnesite as a lining material for cement kilns. *Tonind. Ztg.* 55 (77), 1081-82 (1931); *Rock Prod.* 35, No. 8, 58 (1932). *Cer. Abs.* 11, No. 1,

36 (1932).—The use of magnesite bricks as a lining for cement kilns was not considered practical up to now. Experiments point, however, to the fact that well-sintered magnesite will not react with cement. The strength of mortar made from cement and magnesite was found to be not much lower than the strength of pure cement. No blowing was observed in these experiments.

(69) Anon. High-alumina blocks for lining rotary cement kilns. Published by A. L. Curtis, Westmoor Laboratory, Chatteris. 24 pp. *Refrac. Jour.*, (8), 389 (1931); *Zement*, 20 (36), 825 (1931). *Cer. Abs.* 11, No. 4, 250 (1932).

### 1932

(70) C. H. Sonntag. A new cement kiln refractory. *Rock Prod.* 35, No. 22, pp. 48-54 (1932).—Describes the service given by new type of magnesia lining. Introduces the subject with theoretical and practical considerations.

(71) E. De La Follie De Joux. Refractory coating for lime and cement kilns. *Rev. mat. constr. trav. pub.*, No. 268, pp. 9-11B (1932). *Cer. Abs.* 11, No. 5, 310 (1932).—Bricks used in the zone of reheating should be acid. Bricks used in the firing zone should be alkaline. Bricks used in the cooling zone may be less refractory but must resist mechanical wear at high temperature and sudden changes of temperature. See also *Cer. Abs.* 10, No. 10, 707 (1931).

(To be continued.)

## BINDING CASES

FOR

### "CEMENT & LIME MANUFACTURE"

Strong binding cases for the 1939 volume of "Cement and Lime Manufacture" are now ready, price 3s. 6d. (by post, 3s. 9d.) each. These cases are cloth covered, with the title of the journal and the date of the volume blocked in gold on the side and spine. If desired, we will undertake the work of binding at an inclusive charge of 7s. plus 6d. postage: in this case the twelve numbers should be sent post paid to Concrete Publications, Ltd., 14, Dartmouth Street, London, S.W.1. For the information of those who may wish us to complete their sets, all the 1939 numbers are available and can be supplied, price 1s. each.

#### MISCELLANEOUS ADVERTISEMENTS.

##### SCALE OF CHARGES.

*Situations Wanted*, 1d. a word, minimum 2s. 6d. *Situations Vacant*, 1½d. a word: minimum 4s. *Box number* 6d. extra. *Other miscellaneous advertisements*, 1½d. a word, 4s. minimum.

Advertisements must reach this office by the 5th of the month of publication.

#### SITUATION WANTED.

MECHANICAL ENGINEER, with University degree, age 30, experienced in all kinds of cement works, used to act on own responsibility, seeks position at home or abroad. Box 1478, "Cement and Lime Manufacture," 14, Dartmouth Street, Westminster, S.W.1.

#### SITUATION VACANT.

WANTED. Charge Hand for Lime Works in Shropshire. Quarrying, Burning, Grinding, and Hydrating experience. Particulars to Econo-Lime Products, Ltd., Dunstall Road, Wolverhampton.

# CEMENT AND LIME

UNIVERSITY OF WASHINGTON

## MANUFACTURE

MAY 13 1940

XIII. No. 4

APRIL 1940

SEATTLE WASHINGTON  
PRICE 1/- MONTHLY

# GRINDING MEDIA WITH THE SMALLEST WEAR-AND-TEAR COST



*A grade  
and size  
for  
every  
purpose*

### "HELIPEBS"

patent metallic grinding media have accomplished wonderful records in fine grinding by Tube-Mill process.

### "CHROMOIDS"

are made from a special hard and tough alloy, and give forged steel ball service at cast iron ball cost.

### "CRETOIDS"

are a new type of grinding media for producing cement of extreme fineness, and have proved highly successful in finishing mills without any cooling device.

### "SLUGOIDS"

are highly efficient for grinding by the wet process, and make an efficient substitute for small diameter forged steel balls at considerably less cost.

### FORGED HARD STEEL BALLS

are made of high carbon or chrome steel of superior quality and workmanship. Thousands of tons in use in cement works throughout the world.

Samples and prices gladly submitted at short notice and without obligation.

HERE IS NO GRINDING PROBLEM  
THAT CANNOT BE SOLVED BY

# HELIPEBS LTD

Suppliers of the World's Best Grinding Media

GLOUCESTER · ENGLAND

THE MOST UP-TO-DATE AND AUTHORITATIVE WORK ON

# PORTLAND CEMENT

## MANUFACTURE • CHEMISTRY • TESTING

by

**A. C. DAVIS**

M.I.MECH.E., F.C.S.

The author is Works Managing Director of the Associated Portland Cement Manufacturers Limited, the largest group of cement manufacturers in Great Britain, and in this important volume the reader is given the benefit of his unrivalled practical knowledge of every phase of cement manufacture.

The subject is exhaustively dealt with from the selection and winning of raw materials to methods of packing and despatching cement.

Throughout the volume the reader will find valuable information not previously published or available elsewhere.

---

**420 PAGES****280 ILLUSTRATIONS****30 TABLES**

---

### **This book thoroughly discusses and analyses:**

Modern manufacturing methods and organisation.

Formation and nature of cement raw materials throughout the world.

Factors governing choice of materials and manufacturing processes.

Advantages of dry and wet processes.

Raw material and clinker grinding problems:

Advantages and disadvantages of different types of machinery.

Developments in clinker burning, with notes on improving efficiency of the rotary kiln, comparative methods of coal feed, slurry drying, and kiln control.

Exact control of all aspects of the burning operation.

Unit system of coal pulverisers in supply of coal to rotary kilns.

Reactions in burning cement.

Rotary kiln heat balances and the method of obtaining them.

Conservation of heat in rotary kilns.

Advantages and economies of the purchase of electricity compared with power generation at the factory.

Modern methods of packing and despatching cement.

Production costs.

Mineralogy and chemistry of cement.

Full descriptions of methods of sampling and testing cement, with discussions on the theory and practice of various tests.

Review of investigations into theory of setting and methods of control: Advantages and peculiarities of rapid hardening and generation of heat.

Causes of concrete failures and methods of avoiding them.

Price 30s. net.

By Post 31s.

**CONCRETE PUBLICATIONS LIMITED,**  
14, DARTMOUTH STREET, WESTMINSTER, LONDON, S.W.1